AMENDMENTS TO THE SPECIFICATION

Please amend the paragraph beginning on page 1, line 1 as follows:

~~DESCRIPTION~~

Please insert the following paragraph on page 1 after the title:

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a national stage of PCT/JP2004/011243, filed August 5, 2004, which claims priority to Japanese application No. 2003-347471, filed October 6, 2003.

Please amend the paragraph beginning on page 1, line 4 as follows:

~~Technical~~ Field of the Invention

Please amend the paragraph beginning on page 1, line 9 as follows:

Background ~~Art~~ of the invention

Please amend the paragraph beginning on page 1, line 10 as follows:

Fig. 14 illustrates a most-commonly-used conventional twisted waveguide, which is a rectangular waveguide having a twisted structure. Since a rapid twisting of a twisted waveguide having such a structure is not allowed during its manufacturing process, the waveguide requires a predetermined length in the propagation direction of an electromagnetic wave. Moreover, the waveguide also requires a large space in the joint portions. Japanese Unexamined Patent Application Publication No. 62-23201 ("Patent Document 1") discloses a structure for solving these problems. Specifically, Fig. 15 illustrates the structure of a twisted waveguide according to Patent Document 1. In this twisted waveguide, a second rectangular waveguide element 2 is attached in a manner such that the second rectangular waveguide element 2 is inclined at a predetermined angle with respect to a first rectangular waveguide element 1. Furthermore, a resonant window or filter window 3 having a transmission center frequency as a predetermined

frequency is disposed between the first rectangular propagation path element and the second rectangular waveguide element 2 such that a plane of polarization is inclined at 1/2 of the predetermined angle mentioned above.

Please amend the paragraph beginning on page 2, line 6 as follows:

~~Patent Document 1: Japanese Unexamined Patent Application Publication No. 62-23201~~

Please amend the paragraph beginning on page 2, line 8 as follows:

~~Disclosure of the Invention~~

Please amend the paragraph beginning on page 2, line 9 as follows:

~~Problems to be Solved by the Invention~~ <u>Summary of the Invention</u>

Please amend the paragraph beginning on page 2, line 23 as follows:

~~Means for Solving the Problems~~

Please amend the paragraph beginning on page 4, line 23 as follows:

~~Advantages~~

Please amend the paragraph beginning on page 8, line 9 as follows:

~~[Fig. 1]~~ Fig. 1 is a perspective view illustrating a three-dimensional configuration of an electromagnetic-wave propagation path of a twisted waveguide according to a first embodiment <u>of the present invention</u>.

Please amend the paragraph beginning on page 8, line 13 as follows:

~~[Fig. 2]~~ Fig. 2 <u>Figs. 2A, 2B and 2C are</u> ~~includes~~ cross-sectional views each illustrating an element of the twisted waveguide <u>of Fig. 1</u> and an electric-field distribution of an electromagnetic wave.

Please amend the paragraph beginning on page 8, line 15 as follows:

~~[Fig. 3]~~ Fig. 3 illustrates reflection-loss-versus-frequency characteristics of the twisted waveguide of Fig. 1.

Please amend the paragraph beginning on page 8, line 18 as follows:

~~[Fig. 4]~~ ~~Fig. 4 includes~~ Figs. 4A, and 4B are cross-sectional views each illustrating a connection element of a twisted waveguide according to a second and third embodiment of the present invention.

Please amend the paragraph beginning on page 8, line 21 as follows:

~~[Fig. 5]~~ Fig. 5 is a perspective view illustrating a three-dimensional configuration of an electromagnetic-wave propagation path of a twisted waveguide according to a ~~third~~ fourth embodiment of the present invention.

Please amend the paragraph beginning on page 8, line 25 as follows:

~~[Fig. 6]~~ ~~Fig. 6 includes~~ Figs. 6A, 6B and 6C are cross-sectional views illustrating three structural types of a connection element of a twisted waveguide according to a ~~fourth~~ fifth embodiment of the present invention.

Please amend the paragraph beginning on page 9, line 3 as follows:

~~[Fig. 7]~~ ~~Fig. 7 includes~~ Figs. 7A-7D are cross-sectional views of the elements of the twisted waveguide according to the fourth embodiment.

Please amend the paragraph beginning on page 9, line 6 as follows:

~~[Fig. 8]~~ Fig. 8 is a perspective view illustrating a three-dimensional configuration of an electromagnetic-wave propagation path of a twisted waveguide according to a ~~fifth~~ sixth embodiment.

Please amend the paragraph beginning on page 9, line 10 as follows:

~~[Fig. 9] Fig. 9~~ Figs. 9A and 9B are ~~includes~~ cross-sectional views each illustrating a connection element of a twisted waveguide according to a ~~sixth~~ seventh and eighth embodiment of the present invention.

Please amend the paragraph beginning on page 9, line 13 as follows:

~~[Fig. 10] Fig. 10 includes a diagram illustrating~~ Fig. 10A is a three-dimensional configuration of an electromagnetic-wave propagation path of a twisted waveguide according to a ~~seventh~~ ninth embodiment, and Figs. 10B-10E are cross-sectional views of the elements of Fig. 10A.

Please amend the paragraph beginning on page 9, line 18 as follows:

~~[Fig. 11]~~ Fig. 11 illustrates S-parameter-versus-frequency characteristics of the twisted waveguide of Fig. 10A.

Please amend the paragraph beginning on page 9, line 20 as follows:

~~[Fig. 12] Fig. 12 includes diagrams illustrating~~ Figs. 12A and 12B show a primary radiator and a dielectric-lens antenna provided in an extremely-high-frequency radar according to an ~~eighth~~ tenth embodiment.

Please amend the paragraph beginning on page 9, line 24 as follows:

~~[Fig. 13]~~ Fig. 13 is a block diagram illustrating a signal system of the extremely-high-frequency radar.

Please amend the paragraph beginning on page 10, line 1 as follows:

~~[Fig. 14]~~ Fig. 14 is a perspective view of a conventional twisted waveguide.

Please amend the paragraph beginning on page 10, line 3 as follows:

~~[Fig. 15]~~ Fig. 15 illustrates a twisted waveguide according to Patent Document 1.

Please amend the paragraph beginning on page 10, line 5 as follows:

Reference Numerals shown in the Drawings

Please amend the paragraph beginning on page 10, line 17 as follows:

~~Best Mode for Carrying Out~~ Detailed Description of Preferred Embodiments of the Invention

Please amend the paragraph beginning on page 10, line 20 as follows:

Fig. 1 is a perspective view illustrating a three-dimensional configuration of an inside (electromagnetic-wave propagation path) of a twisted waveguide 110. The [[A]] twisted waveguide 110 includes a first rectangular waveguide element 10 corresponding to a first rectangular propagation path element ~~according to the present invention~~; a second rectangular waveguide element 20 corresponding to a second rectangular propagation path element ~~according to the present invention~~; and a connection element 30 connecting the first rectangular waveguide element 10 and the second rectangular waveguide element 20. The first rectangular waveguide element 10 and the second rectangular waveguide element 20 propagate an electromagnetic wave of TE10 mode and each have an H plane extending longitudinally and an E plane extending laterally when viewed in cross section taken along a plane perpendicular to a direction of electromagnetic-wave propagation. The reference characters H in Fig. 1 each indicate a surface parallel to a loop plane (H plane) of a magnetic field. ~~On the other hand, each~~ Each reference character E indicates a surface parallel to a plane (E plane) extending parallel to a direction of an electric field. The first rectangular waveguide element 10, the second rectangular waveguide element 20, and the connection element 30 have a common central axis O (Figs. 2A-2C) collinearly extending in the direction of electromagnetic-wave propagation.

Please amend the paragraph beginning on page 12, line 10 as follows:

~~Fig. 2 includes~~ Figs. 2A through 2C are cross-sectional views of the elements shown in Fig. 1, and ~~while~~ each cross-sectional view is taken along a plane perpendicular to the direction of electromagnetic-wave propagation. Similar to Fig. 1, only an internal space of the electromagnetic-wave propagation path is shown. Specifically, ~~diagram (A)~~ Fig. 2A is a cross-sectional view of the first rectangular waveguide element 10, ~~diagram~~

~~(C)~~ Fig. 2C is a cross-sectional view of the second rectangular waveguide element 20, and ~~diagram (B)~~ Fig. 2B is a cross-sectional view of the connection element 30. A pattern including multiple triangles in each drawing indicates an electric-field distribution of an electromagnetic wave of TE10 mode propagating through the twisted waveguide. In other words, the pointing direction of the triangles of the pattern indicates the direction of the electric field, and the size and the density of the triangles of the pattern indicate the magnitude of the electric field. In ~~diagrams (A)~~ Figs. 2A and 2C ~~(C)~~, each reference character H indicates a surface parallel to H plane, and each reference character E indicates a surface parallel to E plane. Referring to ~~diagrams (A)~~ Figs. 2AFigs. 2A and 2C ~~(C)~~, the electric field of TE10 mode extends in a direction parallel to E plane, and the intensity of the electric field is greater towards the center of each waveguide element. As described above, the first rectangular waveguide element 10, the second rectangular waveguide element 20, and the connection element 30 have a common central axis O collinearly extending in the direction of electromagnetic-wave propagation.

Please amend the paragraph beginning on page 13, line 14 as follows:

Referring to ~~diagram (B) in~~ Fig. 2B, the connection element 30 is provided with a pair of projections 31a, 32a projected inward so as to face each other, and a pair of projections 31b, 32b also projected inward so as to face each other. The inner periphery of the connection element 30 includes surfaces Sh01, Sh02, Sh03, Sh11, Sh12, Sh13 which are parallel to H plane of the first rectangular waveguide element 10; and surfaces Sv01, Sv02, Sv11, Sv12, Sv10, Sv20 which are parallel to E plane of the first rectangular waveguide element 10. These surfaces parallel to H plane and the surfaces parallel to E plane constitute a staircase-like structure. The direction of inclination of the staircase corresponds to the direction in which H plane of the second rectangular waveguide element 20 is inclined. In this embodiment, the staircase is inclined at an angle of 22.5°, which is substantially 1/2 of the angle of inclination of H plane of the second rectangular waveguide element 20.

Please amend the paragraph beginning on page 14, line 21 as follows:

Referring to Figs. 1, 2A, 2B and 2C ~~1 and 2~~, the waveguide element 10 and the waveguide element 20 have different planes of polarization but have the same cross-sectional structure. For this reason, a reflection coefficient as viewed from the side of the waveguide element 10 towards the connection element 30 and a reflection coefficient as viewed from the side of the waveguide element 20 towards the connection element 30 can be made equal to each other in a relatively easy manner by adjusting the height of the projections and the width of the projections in the connection element 30. When the reflection coefficient viewed from the side of the waveguide element 10 towards the connection element 30 and the reflection coefficient viewed from the side of the waveguide element 20 towards the connection element 30 are equal to each other, the reflection coefficient viewed from the side of the waveguide element 10 towards the connection element 30 and the reflection coefficient viewed from the side of the connection element 30 towards the waveguide element 20 have the same magnitude with reversed polarities.

Please amend the paragraph beginning on page 17, line 8 as follows:

~~Fig. 4 includes diagrams illustrating a~~ Figs. 4A and 4B show twisted waveguides according to a second and third embodiment, respectively, of the invention. ~~Diagrams (A) and (B)~~ Figs. 4A and 4B are cross-sectional views of connection elements having different structures taken along a plane perpendicular to the direction of electromagnetic-wave propagation, one of the connection elements being included in the twisted waveguide. In contrast to the first embodiment shown in ~~Figs. 1 and 2~~ Fig. 1 provided with two pairs of projections (a total of four projections) projected inward to face each other, the second embodiment ~~example~~ shown in Fig. 4A ~~diagram (A)~~ is provided with three pairs of projections (a total of six projections). Furthermore, the ~~example~~ third embodiment shown in Fig. 4B ~~diagram (B)~~ is provided with five pairs of projections (a total of 10 projections). Accordingly, the connection element 30 may be provided with a desired number of projections.

Please amend the paragraph beginning on page 17, line 23 as follows:

Fig. 5 illustrates a twisted waveguide according to a ~~third~~ fourth embodiment. In this embodiment, H plane of the second rectangular waveguide element 20 is inclined at an angle of 15° with respect to H plane of the first rectangular waveguide element 10. This means that the connection element 30 rotates the plane of polarization of an electromagnetic wave propagating through the connection element 30 by an angle of 15°. Consequently, when the rotation angle is to be reduced, the angle of inclination of the staircase portion of the connection element 30 is made smaller, whereby the height of each step of the staircase is reduced. In contrast, if the rotation angle is to be increased, the angle of inclination of the staircase portion of the connection element 30 is made larger, whereby the height of each step of the staircase is increased.

Please amend the paragraph beginning on page 18, line 13 as follows:

A twisted waveguide according to a ~~fourth~~ fifth embodiment will now be described with reference to Figs. 6A through 7D ~~6 and 7~~.

Please amend the paragraph beginning on page 18, line 15 as follows:

Each of the drawings mentioned above illustrates only the internal structure of the electromagnetic-wave propagation path. Specifically, the twisted waveguide can be formed by assembling together a plurality of metal blocks having grooves formed therein by, for example, cutting. ~~Fig. 6~~ Figs. 6A-6C show ~~includes diagrams illustrating~~ three examples of such an assembly. Each diagram is a cross-sectional view of the connection element taken along a plane perpendicular to the direction of electromagnetic-wave propagation. A broken line in the diagrams corresponds to an attachment plane (dividing plane) between metal blocks. The relationship between the connection element and the first and second rectangular waveguide elements is the same as that shown in Figs. 1 and 2. In each of Figs. 6A and 6C ~~diagrams (A) and (C)~~, a plane parallel to H plane of the first rectangular waveguide element functions as a dividing plane. Specifically, in Fig. 6A ~~diagram (A)~~, the dividing plane is set such that a

groove formed in a metal block 101 has a smaller number of inner surfaces therein. On the other hand, Fig. 6C ~~in diagram (C)~~, the dividing plane is set across the center of the connection element such that grooves provided in upper and lower metal blocks 100, 101 are symmetrical to each other.

Please amend the paragraph beginning on page 19, line 12 as follows:

In an example shown in Fig. 6B ~~diagram (B)~~, planes parallel to E plane of the first rectangular waveguide element function as dividing planes. Each dividing plane is set such that upper and lower projections of a corresponding pair facing each other is included in the same dividing plane. According to this structure, the shape of grooves provided in metal blocks 100, 101, and 102 is simplified, thereby achieving an easier machining process.

Please amend the paragraph beginning on page 19, line 20 as follows:

~~Fig. 7 includes~~ Figs. 7A-7D are cross-sectional views of the elements including the first and second rectangular waveguide elements in a case where the connection element has the structure shown in ~~diagram (A) in~~ Fig. 6A. ~~Diagram (D) in~~ Fig. 7D is an exploded perspective view of this twisted waveguide. ~~Specifically, diagram (A)~~ Fig. 7A is a cross-sectional view of the first rectangular waveguide element 10, Fig. 7B ~~diagram (B)~~ is a cross-sectional view of the connection element 30, and Fig. 7C ~~diagram (C)~~ is a cross-sectional view of the second rectangular waveguide element 20.

Please amend the paragraph beginning on page 20, line 5 as follows:

An upper metal block 101 and a lower metal block 100 are each provided with a groove for forming the first rectangular waveguide element 10 and the connection element 30. The lower metal block 100 is integrally provided with a protrusion 102 in which the second rectangular waveguide element 20 is provided. On the other hand, the upper metal block 101 is provided with a recess which engages with this protrusion 102.

Please amend the paragraph beginning on page 20, line 18 as follows:

Fig. 8 is a perspective view of a twisted waveguide according to a sixth ~~fifth~~ embodiment of the present invention. Although the first and second rectangular waveguide elements 10, 20 according to the embodiments shown in, for example, Figs. 1 and 5 have the same size, these two elements may have different sizes. In the ~~this~~ embodiment shown in Fig. 8, the first rectangular waveguide element 10 is a W-band rectangular waveguide element (75 to 110 GHz) having a preferred size of 2.54 mm × 1.27 mm, and the second rectangular waveguide element 20 is a V-band rectangular waveguide element (50 to 75 GHz) having a preferred size of 3.10 mm × 1.55 mm.

Please amend the paragraph beginning on page 21, line 15 as follows:

~~Fig. 9 includes diagrams illustrating~~ Figs. 9A and 9B show a main portion of a twisted waveguide according to a ~~sixth~~ seventh and eighth, respectively, of the present invention embodiment. In these embodiments ~~this embodiment~~, a pair of projections 31, 32 (a total of two projections) facing each other is provided. In Figs. 9A and 9B ~~diagrams (A) and (B)~~, the direction of inclination of the staircase of the connection element 30 corresponds to the direction in which H plane of the second rectangular waveguide element is inclined such that a plane of polarization of an electromagnetic wave can be rotated. ~~However, in diagram (A)~~ In Fig 9A, however, since the two projections 31, 32 face each other in a direction parallel to E plane of the first rectangular waveguide element, a region in which the electric field is concentrated due to the two projections 31, 32 extends parallel to E plane of the first rectangular waveguide element. This results in a low ability for rotating the plane of polarization of an electromagnetic wave propagating through the connection element 30 towards the plane of polarization in the second rectangular waveguide element. In contrast, in Fig. 9B ~~in diagram (B)~~, a plane extending between the projections 31, 32 facing each other is inclined towards E plane of the second rectangular waveguide element with respect to E plane of the first rectangular waveguide element. Thus, the electric field that is concentrated in a region between the two projections 31, 32 is tilted towards E plane of the second rectangular waveguide element. Accordingly, when the electromagnetic wave entering from the first rectangular waveguide element propagates through the

connection element 30, the electromagnetic wave is efficiently rotated towards E plane of the second rectangular waveguide element. According to this structure provided with only a single pair of projections, a rotating effect for the plane of polarization of the electromagnetic wave can still be achieved.

Please amend the paragraph beginning on page 22, line 23 as follows:

A twisted waveguide according to a ~~seventh~~ ninth embodiment will now be described with reference to Figs. 10A through 10E and 11.

Please amend the paragraph beginning on page 22, line 25 as follows:

~~Fig. 10 includes a perspective view illustrating the overall structure of the twisted waveguide, and cross-sectional views of the elements taken along a plane perpendicular to the electromagnetic-wave propagation path. Specifically, diagram (A)~~ Fig. 10A is a perspective view illustrating a three-dimensional configuration of the electromagnetic-wave propagation path. An edge line R forming a hexahedron indicates an outline of assembled metal blocks that form the waveguide elements. The first rectangular waveguide element 10 and the second rectangular waveguide element 20 have the connection element 30 disposed therebetween, and moreover, the connection element 30 includes a first connection subelement 30a and a second connection subelement 30b in this embodiment. ~~Diagram (B) in~~ Fig. 10B is a cross-sectional view of the first rectangular waveguide element 10, ~~diagram (C)~~ Fig. 10C is a cross-sectional view of the first connection subelement 30a, ~~diagram (D)~~ Fig. 10D is a cross-sectional view of the second connection subelement 30b, and ~~diagram (E)~~ Fig. 10E is a cross-sectional view of the second rectangular waveguide element 20. The dimensions of the elements shown in these diagrams are in millimeter units. Furthermore, the line length of the first connection subelement 30a in the direction of electromagnetic-wave propagation is preferably 1.46 mm, and the line length of the second connection subelement 30b in the direction of electromagnetic-wave propagation is preferably 1.33 mm. The total line length of the first and second connection subelements 30a, 30b is 1/2 of a guide wavelength with respect to a frequency of an electromagnetic wave to be propagated

through the first and second connection subelements. Furthermore, the polarity of the reflection coefficient at the bordering section between the first rectangular waveguide element 10 and the first connection subelement 30a is opposite to the polarity of the reflection coefficient at the bordering section between the second rectangular waveguide element 20 and the second connection subelement 30b. Accordingly, two reflective waves generated at the two bordering sections counteract each other, whereby a low reflection-loss characteristic can be achieved.

Please amend the paragraph beginning on page 25, line 13 as follows:

Fig. 11 illustrates S-parameter-versus-frequency characteristics of the twisted waveguide shown in Fig. 10A. According to a transmissive property S21, a low loss characteristic of -0.5 dB or less is achieved over the range of 71 to 81 GHz or more. Moreover, a low reflection characteristic of -25 dB or less is also achieved over the same frequency range.

Please amend the paragraph beginning on page 25, line 20 as follows:

An extremely-high-frequency radar according to an ~~eighth~~ tenth embodiment will now be described with reference to Figs. 12A, 12B and 13.

Please amend the paragraph beginning on page 25, line 23 as follows:

~~Fig. 12 includes~~ Figs. 12A and 12B are perspective views of a dielectric-lens antenna provided in the extremely-high-frequency radar. ~~Diagram (A) illustrates~~ Fig. 12A shows a primary radiator included in the dielectric-lens antenna. Here, a rectangular horn 21 corresponds to the second rectangular propagation path element according to the present invention. The connection element 30 including the first and second connection subelements 30a, 30b is disposed between the rectangular horn 21 and the first rectangular waveguide element 10. The connection element 30 rotates a plane of polarization of an electromagnetic wave propagating through the connection element 30. Accordingly, the first rectangular waveguide element 10, the connection element 30, and the rectangular horn 21 constitute a primary radiator 110'.

Please amend the paragraph beginning on page 26, line 12 as follows:

~~Diagram (B) illustrates~~ Fig. 12B the structure of the dielectric-lens antenna. The rectangular horn 21 of the primary radiator 110' is disposed near a focal position of a dielectric lens 40, and can be relatively shifted with respect to the dielectric lens 40 so as to scan sending and receiving wave beams. Although a rectangular horn is provided in the primary radiator in this embodiment, the primary radiator may alternatively be provided with, for example, a cylindrical horn, a patch antenna, a slot antenna, or a dielectric rod antenna.